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BIENNIAL REPORT

OF THE

DEPARTMENT OF HIGHWAYS

OF THE

STATE OF CALIFORNIA.

DECEMBER, 1904.

N. ELLERY, - - - - - COMMISSIONER.



SACRAMENTO:

W. W. SHANNON, : : : : SUPERINTENDENT STATE PRINTING.
1905

REPORT OF THE DEPARTMENT OF HIGHWAYS.

During the past year there has been an increased interest in the public welfare of the State by the Department of Highways. The use of state roads is at its greatest point in this work, and last Saturday morning over 2,000 vehicles of all kinds were on the state roads between. Through the improved roads the good roads movement is spreading throughout the State. There are now more than 1,000 miles of good roads in California.

STATE CAPITOL, SACRAMENTO, CALIFORNIA,
DEPARTMENT OF HIGHWAYS,
November 28, 1904.

To His Excellency, GEORGE C. PARDEE,
Governor of the State of California:

SIR: I herewith submit for your consideration the work of the Department of Highways, covering the period from November 1, 1902, to November 1, 1904, as provided for in Chapter CCLXXII of Statutes and Amendments, 1897; and, appended thereto, the Report of the Lake Tahoe Wagon Road Commissioner.

Very respectfully,

N. ELLERY,
Highway Commissioner.

Attest: CLARK ALBERTI, Secretary.

REPORT OF THE DEPARTMENT OF HIGHWAYS.

During the past two years, there has been an augmented activity by the various counties of the State in the improvement of the county roads. The use of cheap asphaltic oil has, no doubt, greatly assisted in this work, and has considerably improved over 2,000 miles of the 45,000 miles of the roads within California. Through the impetus given the good-roads movement by the application of crude oil to road surfaces, there has been developed a strong desire to construct more permanent roads than we now possess. This partially sprang from the apparent necessity for such in connection with the oiled roads. However, their construction quite often was incomplete. The many diversified opinions without consideration of the fundamental road principles have led to many diversified results; and in some instances where individual interest guided the work, excellent roads were obtained, while a considerable mileage was benefited only in so far as the dust was laid, allowing the road in winter to become decidedly bad and incapable of facilitating heavy hauling.

Information received by this Department concerning oiled roads, and personal observation of the numerous examples, clearly indicate a lack of systematic work. Such defects as are apparent not only exist in oiled roads, but generally pervade our whole system of road-making. Thus while we have bettered some of our roads, we still fall far below the standard of efficiency that should obtain, and practically remain in the same condition in which our application of road affairs has hitherto placed us.

From the figures taken from the records of the counties of this State, the road expenditures have increased, until now the total for the fiscal years 1902-03 and 1903-04 is \$4,310,921—an increase of \$543,883 over the prior two fiscal years. The expenditure of \$2,000,000 per annum for highway work should of itself attract attention enough to make certain the solution of the problem of good substantial roads for our communities, but it is to be regretted such has not been the case up to the present time. Since railroads have been constructed into nearly all sections of the State and are doing the larger share of the business of the main common roads, the opinion prevails among many that the principal function of the road should be but a feeder to the railroad. It is the fact that the short line of road leading from the interior to the

nearest railway station is a very important factor to the farming interest, and should be developed to its highest efficiency; but from this it does not follow that the improvement of our main roads would not be a vast saving to the State. These long stretches of principal highways, if made good, contribute their part toward the reduction of transportation rates just as the improvement of the waterways brings such rates, in competition, to a reasonable basis which can be maintained. And further, the main roads do and will exist for the pleasure, communication, and business of the whole people; and since the counties are endeavoring to keep them in shape, why not introduce a system of economy in the expenditure that will place them in condition for an extension of the present uses and eventually reduce road taxation? The remedy is apparent. This branch of our public service should be placed on a definite and systematic plan, obtained through changes in our present laws sufficient to develop a keen interest of the public for substantial roads.

The more progressive Eastern States had a similar experience to ours, and eventually overcame it by the passage of State-aid laws. The plan has worked admirably and has given the relief sought. These laws have created a strong favorable public interest, and have resulted in the building of excellent and economic roads, which in time will prove the wisdom of their enactment in reducing the road tax to a minimum as soon as the period of construction ends. The problem of good roads is practically solved, and those States are spending millions of dollars in construction work. Therefore, after their practical experience and success, California is able to approach the plan with assurance, and in consequence the following law, closely resembling the New York aid law, is recommended for enactment:

AN ACT TO PROVIDE FOR THE IMPROVEMENT OF THE PUBLIC HIGHWAYS, AND TO MAKE AN APPROPRIATION THEREFOR.

The People of the State of California, represented in Senate and Assembly, do enact as follows:

SECTION 1. The Board of Supervisors in any county of the State may, and upon presentation of a petition as provided in section two hereof must, pass a resolution that public interest demands the improvement of any public highway, or section thereof, situate within such county, and described in such resolution; but such description shall not include any portion of a highway within the boundaries of any city or incorporated village; and within ten days after the passage of such a resolution shall transmit a certified copy thereof to the State Highway Commissioner.

SEC. 2. The owners of two thirds of the lineal feet fronting on any such public highway or section thereof in any county of the State may present to the Board of Supervisors of such county a petition setting forth that the petitioners are such owners and that they desire that such highway or section thereof be improved under the provisions of this Act.

SEC. 3. Such Highway Commissioner, upon receipt of such resolution, shall investigate and determine whether the highway or section thereof sought to be improved is of sufficient public importance to come within the purposes of this Act, taking into account the use, location, and value of such highway or section thereof for the pur-

poses of common traffic and travel, and after such investigation shall certify his approval or disapproval of such resolution. If he shall disapprove such resolution, he shall certify his reasons therefor to such Board of Supervisors.

SEC. 4. If he shall approve such resolution, such Highway Commissioner shall cause the highway or section thereof therein described to be mapped both in outline and profile. He shall indicate how much of such highway or section thereof may be improved by deviation from the existing lines whenever it shall be deemed of advantage to obtain a shorter or more direct road without lessening its usefulness or wherever such deviation is of advantage by reason of lessened gradients. He shall also cause plans and specifications of such highways or section thereof to be thus improved to be made for telford, macadam, or gravel roadway or other suitable construction, taking into consideration climate, soil, and materials to be had in the vicinity thereof and the extent and nature of the traffic likely to be upon such highway, specifying in his judgment the kind of road a wise economy demands. The improved or permanent roadway of all highways so improved shall not be less than eight feet nor more than sixteen feet in width, unless for special reasons to be stated by such Highway Commissioner it is required that it shall be a greater width. He shall if requested by the resolution include provision for steel-plate or other flat-rail construction in double track.

SEC. 5. Upon the completion of such maps, plans, and specifications such Highway Commissioner shall cause an estimate to be made of the cost of construction of the same and transmit the same to the Board of Supervisors from which such resolution proceeded, together with a certified copy of such maps, plans, specifications, and of his certificate of the approval of the highway or section thereof so designated as aforesaid.

SEC. 6. After the receipt thereof, upon a majority vote of such Board of Supervisors, it may adopt a resolution that such highway or section thereof so approved shall be constructed under the provisions of this Act, or of any existing Act, and thereupon shall transmit a certified copy of such resolution to such Highway Commissioner.

SEC. 7. In case the boundaries of such proposed highway shall deviate from the existing highway, the Board of Supervisors must make provisions for securing the requisite right of way prior to the actual commencement of the work of improvement.

SEC. 8. Upon receipt of the certified copy of the resolution provided in section six, such Highway Commissioner shall advertise for bids once a week for four successive weeks in a newspaper published at the county seat of such county and in one such other newspaper as shall be deemed of advantage for the construction of such highway or section thereof, according to such plans and specifications, and award such contract to the lowest responsible bidder, except that he may in his discretion award the contract to the Board of Supervisors in the county in which such highway lies, provided that they shall agree to do said work at a cost at least ten per cent less than the lowest bid received, and except that no contract shall be awarded at a greater sum than the estimate provided in section five. But if no bid otherwise acceptable be made within such estimate, such Highway Commissioner may amend his estimate, certify the same to the Board of Supervisors, and upon the adoption by it of a resolution as provided in section six based on such amended estimate, proceed anew to obtain bids and award the contract as herein provided. Such Highway Commissioner may reject any or all bids, and before entering into any contract for such construction he shall require a bond with sufficient sureties conditioned that if the proposal shall be accepted, the party thereto will perform the work upon the terms proposed and within the time prescribed and in accordance with the plans and specifications; and as a bond of indemnity against any direct or indirect damages that shall be suffered or claimed during the construction of such road, and until the same is accepted. The people of the State of California shall in no case be liable for any damages suffered. Partial payments may be provided for in the contract, and paid in the manner herein provided when certified to by such Highway Commissioner, to an amount not to exceed seventy-five per cent of the value of the work done; twenty-five per cent of the contract price shall be retained until the entire work has been accepted. Whenever a county engineer or surveyor has been appointed or elected in the county in which such highway or section thereof is to be constructed, he shall have general charge and supervision of the work under the direction of the Highway Commissioner, and shall report to him from time to time the progress of the work and such facts in relation thereto as may be required. If there is

no county engineer or surveyor, such Highway Commissioner shall have some competent person to superintend and have engineering supervision of the work.

SEC. 9. Two fifths of the expense of the construction thereof shall be paid by the State Treasurer upon the warrant of the Controller, issued upon the requisition of such Highway Commissioner, out of any specific appropriations made to carry out the provisions of this Act. And three fifths of the expense thereof shall be a county charge in the first instance, and the same shall be paid by the County Treasurer of the county in which such highway or section thereof is, upon the requisition of such engineer or surveyor; but the amounts so paid shall be apportioned by the Board of Supervisors, so that if the same has been built upon a resolution of said board without petition, forty per cent of the cost of construction shall be a general county charge, and twenty per cent shall be a charge upon the road district in which the improved highway or section thereof is located, and if the same has been built upon a resolution of said board after petition as provided in section two, forty per cent shall be a general county charge and twenty per cent shall be assessed upon and paid by the owners of the lands benefited in the proportion of the benefits accruing to said owners as determined by the County Assessor in the next section hereof.

SEC. 10. The Assessor of the county in which any highway or section thereof has been improved or constructed pursuant to petition as provided in section two of this Act, shall have power, and it shall be his duty upon receiving notice from the Board of Supervisors of the county of the cost of construction or improvement of such highway or section thereof in such road district, to assess an amount equal to twenty per cent of said total cost upon the lands fronting or abutting on such highway or section thereof. Such assessment shall be apportioned according to the benefits accruing to the owners of the lands so located, according to the best judgment of said Assessor, upon at least ten days' notice of the time and place of such apportionment to the persons affected thereby, and after such persons have had an opportunity to be heard, and the assessments so made when duly attested by the oath of such Assessor shall be collected in the same manner as the general taxes of such county are collected.

SEC. 11. The construction and improvement of highways and sections thereof, under the provisions of this Act, shall be taken up and carried forward in the order in which they are finally designated, as determined by the date of the receipt in each case of the certified copy of the resolution provided in section six by such Highway Commissioner as hereinbefore provided.

SEC. 12. Upon the completion of such highways or sections thereof so constructed by such Highway Commissioner and his acceptance of the same and after payment has been made as herein provided, such Highway Commissioner shall inform the Board of Supervisors of such counties that the highways or sections thereof designated have been constructed as herein provided; and he may serve notice on said board to accept such highway thus constructed, which notice shall be filed in the office of the clerk of such county; and twenty days after service and filing of said notice, such highway or section thereof shall be deemed accepted by said Board of Supervisors of said county; and thereafter they shall maintain the same as a county road and apportion the expense as they may be empowered by law. The county wherein such improved highways lie shall care for and keep the same in repair under the direction and supervision of the State Highway Commissioner, and such rules and regulations as he may prescribe. Should the county fail to comply with said rules and regulations, then such Highway Commissioner shall cause the maintenance work to be done, and the cost of the same shall be a county charge, paid for in the same manner as for other county roads.

SEC. 13. Whenever any county has had aid in building any such highway, and it seems advantageous to such Highway Commissioner that a section or sections of highway, not exceeding one mile in length, shall be constructed under this Act to connect these roads together, and would be a great public utility and general convenience, he may serve notice on the Board of Supervisors of such county, and shall file one in the County Clerk's office, designating the highway already constructed and the existing termini, and the section or sections, in his opinion, necessary to be constructed and the reasons therefor. And it shall be the duty of the Board of Supervisors to provide for the construction of such connecting highway or section thereof, within one year after the service and filing of such notice. The procedure for such work shall be in accordance with the provisions of this Act.

SEC. 14. There is hereby appropriated out of any money in the State Treasury not otherwise appropriated, the sum of seventy-five thousand dollars to carry into effect the provisions of this Act.

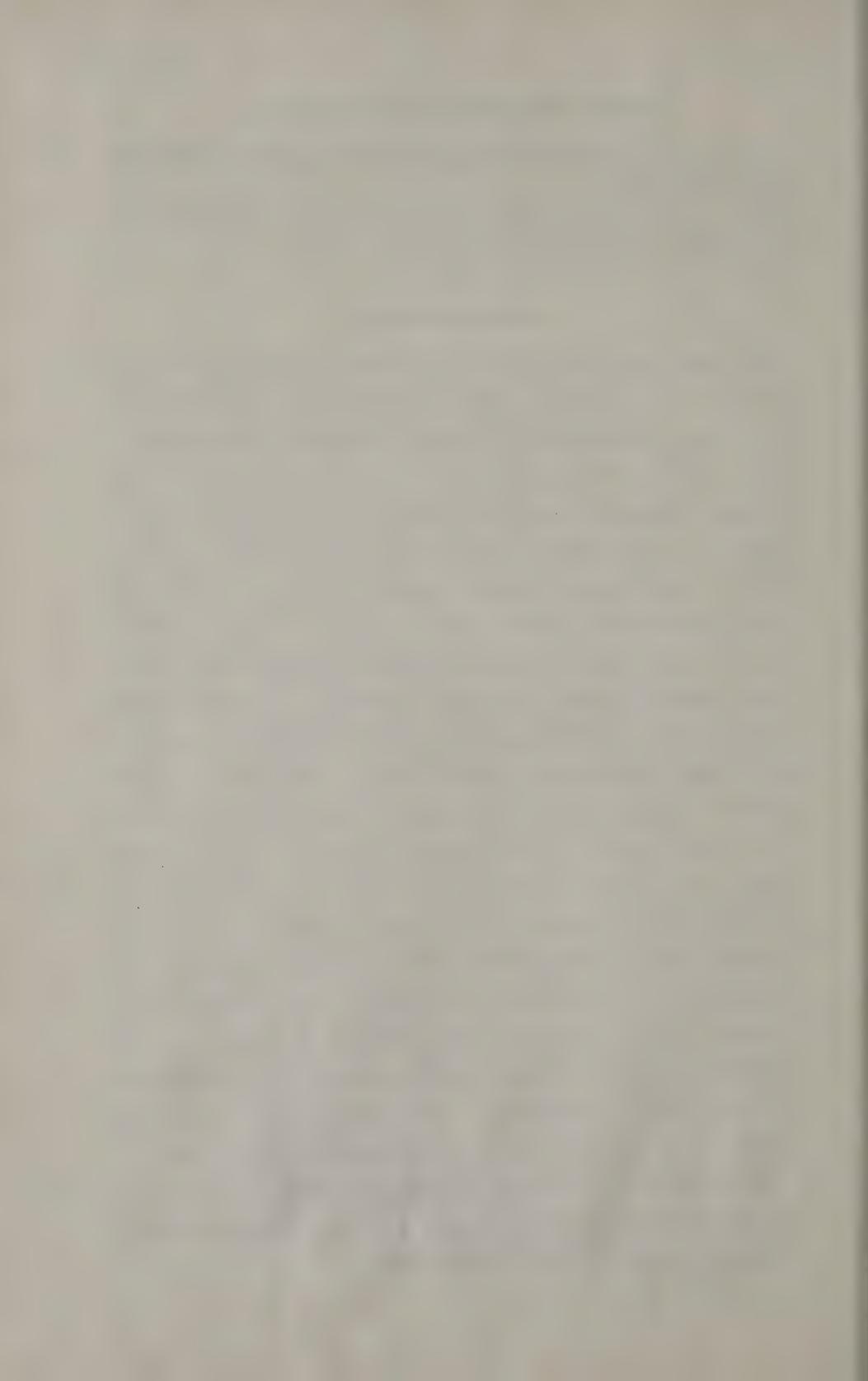
SEC. 15. The operation of this Act shall not be affected by any conflicting Act or conflicting part of any Act wherever the same may now exist, and the highways may be improved under this Act or any existing Act relating to roads.

SEC. 16. This Act shall take effect immediately.

MOUNTAIN ROADS.

The travel incumbent on the Commissioner of this Department in pursuance of his duties and inspection and survey of the State roads has led to a study of the various county roads traversed. In nearly every instance these roads are of excessive grades and not of sufficient width for their purpose. No doubt the ups and downs in the grade could be remedied and thereby give a general reduction in the total elevation. Wherever teams are required to pass each other on narrow stretches of road a sufficient number of turnouts should be made to facilitate travel and to lessen the danger from accident. One remarkable feature of these mountain roads is, where the bed is cut through rocky ground and the winter storms wash away the earth from the rocks in the bed, there is a general tendency to blast or dig out such rocks, thereby creating only a canal for a repetition of the same thing the following season and again a lowering of the roadbed. The proper method certainly is to fill the gullied-out bed to its original surface, and should any rock tend to protrude from the surface, if large, blast the top of it off; if small and loose and near the surface, then remove. Another important item in the maintenance of mountain roads on sidehills is the removal of the surface rocks rolled into the road. They should never, as has been the partial practice, be removed and placed on the upper side of the road, but always on the lower side, where they will not again require handling and expense. If the proper drainage is had by use of more culverts than is the custom, the erosion of the bed can be greatly reduced, thus making the spring opening expense materially less. Care should be taken on the heavier grades where the erosive power of water is great, to have them protected from the surface run-off of water. During the spring of the year when the road is receiving repairs and the fallen trees are being removed, always have the tree trunks cut far enough back to prevent interference with teams, making the cut liberal and avoiding all narrow passages between logs, and always using the utmost care in the repair of the drains so that the water may be kept from both the road foundation and the surface.

In several of the counties of the State their valuation will not permit of any extended road work. Therefore, in such cases the State should grant material assistance, that their development and that of adjoining counties may go on unhampered.



OILED ROADS.

The production in California of oil with an asphalt base has given us a means of cheaply and satisfactorily improving a considerable mileage of our roads. For the past four years its application has gone on with varying results in accordance with the means of construction employed. Close study of the successful and unsuccessful oiled roads of the State leads us to certain deductions which we must carefully regard if we are to make the progress this process offers.

Numerous instances exist where the oil was applied to a road without any previous preparation, with the result that the dust was laid, but very little other improvement occurred. Again, wherever due care in the constructive work was exercised, and an interest taken, we find some excellent results of a permanent nature. With the earnest desire to bring road-oiling and work incident thereto to its proper place, the following suggestions are made:

Foundation.—No road which has been constructed without a proper foundation will ever be wholly successful. If a macadam road is being built, give thorough attention to the details of its base so that its capacity to resist the pressure from above is sufficient, and keep the density of the work as uniform as possible, so that weak spots or ruts may be reduced to a minimum. This applies equally to an earth road. Compact, as much as practicable, the roadbed, keeping always in mind that a smooth, even foundation makes a smooth, even surface. The neglect of the foregoing stamps the work as incomplete and without good road value.

Drains and Ditches.—Whatever be the kind of road, it should be well drained and ditched, so that the sub-grade will be as free from water as can well be made. In low, damp ground the roadbed should be raised high enough to prevent a saturated base; and on the roadside should be good, deep ditches conducting the water away from the road. With the oiled road the drainage should be such as to keep the water from getting under the oiled surface and creating a disagreeable oiled mud during the wet season. Experience with a number of oiled roads has proven this conclusively.

Surfacing.—The top layer should be worked down as perfectly as the means will permit. With the earth road heavy rolling can not be overdone. Saturate the road material with water, but not excessively; practice will soon determine how much should be used. In the damp winter climate of central and northern California, it is well to give a good heavy crown that the rain may be readily shed and thereby allow no chance for percolation to the sub-grade. Preparatory to the oiling, the surface should be dried out to a depth of at least two inches,

for oil will not mix with a wet material. Do not allow teams to pass over a road thus prepared and break the surface irregularly, but loosen evenly just enough of the road surface to allow for the absorption and retention of the oil, otherwise it would run to the sides of the road.

Oiling.—The application should be by means of an oil wagon, which may be operated at will in spreading quantities necessary to a proper coating on the particular road being worked. There are several makes of good oil wagons on the market, any of which, properly handled, will do good work. However, the fact should not be overlooked that extra broad tires for such wagons are the best. After spreading the oil, cover it with a material to give it body. Sand has been preferably used for this purpose, because it is a natural absorbent of oil. Vary the application of sand just enough to cause the mass to be consistent, and allow no places where the oil stands free in small puddles. When this is accomplished, then should the road be rolled, beginning lightly at first and continuing heavier as the mass becomes compacted, until there is no perceptible yielding. Now keep off the travel, if possible, until the oiled material has been allowed to set, and develop all of its asphalt qualities.

In the matter of whether hot or cold oil should be applied it may be said good oiled roads have been obtained by either process; but as cold oil is considerably cheaper, my preference is by all means for cold oil. The claim that hot oil penetrates faster and deeper than cold oil is, perhaps, not without some truth, yet as it takes some time after application for the asphaltic qualities of the oil to be asserted, there is no particular advantage gained, and with the present sanding method the cold oil is absorbed sufficiently for practical purposes.

The selection of the oil is a matter of vital importance. Always seek that quality which contains the highest percentage of asphalt. The proper plan is to have a test for asphalt made to ascertain the amount of such substance when the oil becomes dry. For this purpose herewith is given an excellent test and a table of results compiled by the State Mining Bureau:

Test.—“Probably the best, certainly the simplest, test of the road-making value of an oil is to evaporate a weighed sample in an open metal dish, down to the hardness of commercial ‘D’ asphalt, and weigh the residue. We thus get at once both the original asphalt and that formed during evaporation, and while it is not likely that the percentage of asphalt thus obtained is the same as would be gotten by allowing the oil to dry in the sun, yet is highly probable that the comparison between different oils thus made is accurate. This test requires no apparatus except an iron or copper pan, a scale, and a plumber’s fire-pot, though it must be admitted that the even grading of the asphalt requires care and a little skill.”

Comparison of Road-Making Value of Crude Oils.

Sample No.	Source.	Gravity.	Asphalt*	Sample No.	Source.	Gravity.	Asphalt*
1464	Colorado	41.3	None.	2452	Coalinga	18.7	24.7
1400	Canada	34.9	None.	2432	Sargent	18.6	41.3
1407	Coalinga	33.3	Trace	2462	Newhall	17.2	28.9
2441	Fullerton	33.0	19.1	2437	Midway	17.1	40.5
2438	Fullerton	32.8	20.4	487	Kern River	17.0	25.0
2402	Kansas	31.4	None.	2445	Fullerton	15.9	45.9
2426	Puente	28.0	26.1	2453	Coalinga	15.9	35.5
2442	Ventura	28.0	29.5	2463	Los Angeles	15.7	25.7
2433	Ventura	26.8	13.1	2440	Coalinga	15.7	30.4
495	Wyoming	23.7	33.7	2444	McKittrick	15.1	27.8
2424	Fullerton	23.3	36.5	2496	Kern River	14.3	48.5
2448	Whittier	23.1	23.3	1432	Sunset	14.1	29.2
494	Beaumont, Tex.	22.6	11.0	2454	Newhall	13.9	52.4
1421	Coalinga	21.2	25.0	2495	Los Angeles	13.0	42.2
2450	Whittier	20.4	30.2	2405	Coalinga	11.9	33.2
1482	Midway	20.2	22.0	486	Sunset	9.9	61.8
1403	McKittrick	18.9	22.6	2400	Santa Barbara	9.0	85.5

*The figures in these columns are considered to be accurate to within three per cent.

Through the proper handling and making of oiled roads there undoubtedly will be developed new ways of utilizing oil for this purpose. My belief is that eventually we will have artificially bituminized roads made from crude oil, and perhaps, in the case of macadam roads, the top layer or metaling may be mixed with oil of heavy asphalt percentage, resulting in a sort of bituminous pavement, which should make a first-class road in every particular.

LAKE TAHOE WAGON ROAD.

It has been the purpose of this Department to advise with the Commissioner of the Lake Tahoe Wagon Road on all matters pertaining to any engineering work thereon or in any matter affecting the betterment of the road. In consequence of this, and an undefined general supervision by this Department and the powers given the State Commissioner by the Act of 1903 relating to the care, management, and protection of State roads, I have assisted in the work of the road and have made trips of inspection over it.

From an appropriation made in 1899 by the Legislature for the improvement of the road and the structures thereon, and to make a survey thereof, the then State Commissioner of this department began, on September 27, 1900, a survey of the Lake Tahoe Wagon Road and continued the same until inclement weather prevented further work that year. The survey having extended over 25 miles of the 60 miles of the road, could not be completed the following year on account of the expenditure of the money appropriated, and therefore the work stands incomplete at this date. Of the work done, all crossings, topographical features, widths of road, grades, and future permanent survey monuments were marked and set. For the purpose of marking the



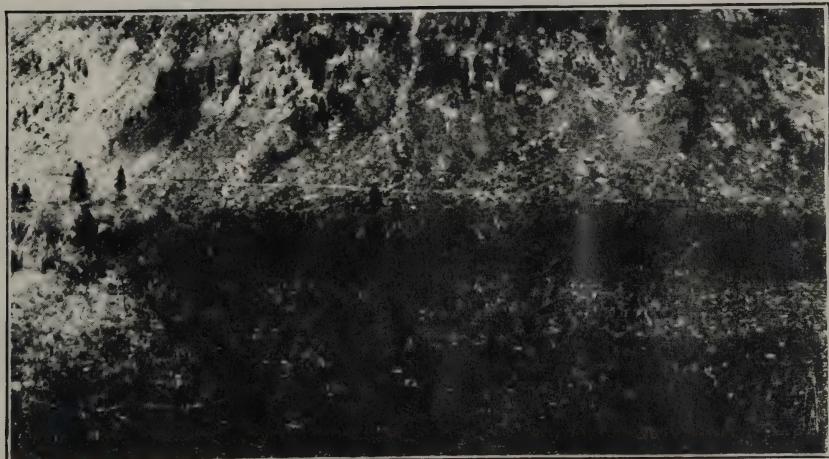
EEL RIVER NEAR SINGLEY'S STATION—SHOWING BANK DESTRUCTION.



PROJECTING BEDROCK, TRINITY RIVER—ONE OF MANY EXCELLENT BRIDGE SITES.



SONORA AND MONO ROAD AT DEADMAN'S CREEK SHOWING GRANITE FORMATION.



MONO LAKE BASIN ROAD. MAXIMUM GRADE OF 7 PER CENT ON THE PART CONSTRUCTED.

total survey, milestones cut of granite at Folsom, of the size 18 inches wide, 6 inches thick, and 54 inches long, and indicating the distance to Placerville, were delivered at Riverton; but with the exception of the first twenty-five, which now represent the survey as far as completed, have not been erected. Without further delay the remaining 33 miles of the road should be surveyed and the thirty-three milestones should be located and set.

For this purpose, I therefore again recommend an appropriation of \$2,000 to be expended under the direction of this Department.

Upon traversing the road during the past two years, my examinations clearly revealed the facts that the maintenance fund of \$4,000 per annum is insufficient to meet the new constructive work to be done. Several small bridges are in a tumbledown shape; stone walling, long ago built insecurely upon, in a number of instances, logs or very poor foundation, have fallen down; numerous old decayed wooden culverts must be replaced, and fills in gullies where brush and logs temporarily served the purpose must now be dug out and be properly rebuilt.

All the permanent work in the culverts and fills that could be done from the money available out of the maintenance fund after grading the road and making the necessary repairs to culverts, bridges, and ditching, was made with either stone or salt-glazed vitrified pipe.

There are ten small bridges which should be replaced with either stone or concrete, two of which—the Trout Creek bridge between the State line and Myer's station, which is a 30-foot span, and a 20-foot span bridge about three miles west of Riverton—are in such bad condition as to require their replacement next summer. Besides this work there are about eighty culverts which need rebuilding, and a considerable length of stone retaining wall at various places along the road should be made.

For the construction of permanent work in culverts, bridges, walls, and large fills, it is recommended that an appropriation of \$15,000 be made, and the expenditure of the same be placed under the control of this Department.

On April 17, 1903, I examined the road as far as Riverton, and made suggestions for the repair of some small bridges, and on September of the same year inspected the summer work on the whole length of road. The office of the Lake Tahoe Wagon Road Commissioner having become vacant in November, 1903, by the death of Mr. S. J. Baker, I assumed charge of the road, disbursed claims to the amount of \$661.85 incurred by him, and collected all papers appertaining to the road, which I turned over to his successor in office, Mr. A. S. Lyon. During 1904 I made two trips over the road—one in June in company with Mr. Lyon, the Commissioner, at which time the summer work was outlined, and one in September viewing the work done.

On April 9, 1904, the El Dorado Lumber Company, a corporation doing business in El Dorado County, made application to this office to construct and maintain a broad-gauge railroad across the Lake Tahoe Wagon Road at a point just above its beginning near Smith's Flat. They filed a map of the location, and after inspection of the point of crossing, the application was granted upon and under rules and restrictions regarding the maintenance of said road by the company at such point, of crossing.

Under the present law, the Commissioner of the Lake Tahoe Wagon Road has direct charge of the road and the expenditure of the maintenance appropriation, thus dividing the State road business in an unsystematical and uneconomical manner. Believing the work could be more advantageously done if directly under the supervision of the Department of Highways, the following law is recommended:

AN ACT TO PLACE THE LAKE TAHOE WAGON ROAD UNDER THE CARE, CONTROL, AND MANAGEMENT AND SUPERVISION OF THE DEPARTMENT OF HIGHWAYS OF THE STATE OF CALIFORNIA; TO PROVIDE FOR NECESSARY ALTERATIONS AND EXTENSIONS OF SAID ROAD, AND THE REPAIR AND CONSTRUCTION OF THE ROAD STRUCTURES THEREON, AND MAKING AN APPROPRIATION THEREFOR.

The People of the State of California, represented in Senate and Assembly, do enact as follows:

SECTION 1. On and after the thirtieth day of June, A. D. nineteen hundred and five, the Department of Highways, State of California, shall have the care, control, management, and supervision of that certain wagon road belonging to the State of California known as the "Lake Tahoe Wagon Road," and situated in the county of El Dorado, in said State, commencing at the junction of the said road with the Placerville and Newton road, a short distance from the village of Smith's Flat, in said county of El Dorado, and running thence to a point on the east boundary line of said State at or near Lake Tahoe.

SEC. 2. It shall be the duty of the Department of Highways to keep said road, and the bridges and culverts thereon, open to travel at all times, except when prevented by the severity of the elements. It shall repair and rebuild said road, or any of the structures thereon, when in its judgment necessary and there are funds provided therefor. The Department of Highways may alter or change the route of said road, and may and shall do all things necessary or proper to care for, manage, maintain, improve, protect, alter, or extend said road, together with its road structures, and in so doing said Department of Highways is authorized to appoint a superintendent and employ assistance, and to procure all material and property, real and personal, in its judgment necessary therefor.

SEC. 3. For the purpose of carrying out the provisions of this Act, and for the repair and reconstruction of defective road structures, where economic and necessary on said road, and for any necessary engineering expenses, the sum of fifteen thousand dollars (\$15,000) is hereby appropriated out of any money in the State Treasury not otherwise appropriated, and the State Controller is hereby directed to draw his warrant from time to time, and in such sums as shall be due on claims presented and approved by the Department of Highways. Said warrant shall be made payable to the Highway Commissioner, and the State Treasurer is hereby directed to pay said warrant, and the Highway Commissioner shall disburse the same.

SEC. 4. All Acts or parts of Acts in conflict with the provisions of this Act are hereby repealed.

SEC. 5. This Act shall take effect and be in force from and after June thirtieth, nineteen hundred and five.

THE SONORA-MONO ROAD.

When the Legislature of 1901 made that part of the Sonora and Mono toll road, extending between Long Barn and Bridgeport, a State highway, it made no appropriation for the maintenance or improvement of the same.

For two years, while under State control, it was therefore subjected to the weather with scarcely any work being done. This, in conjunction with the fact that the road had completely run down and had become almost impassable at the time it came under the charge of this Department, made its repair most difficult and expensive. The bridges, culverts, ditches, fills, and roadbed were in a most deplorable condition.

In 1903 an appropriation of \$2,000 per annum for the maintenance of 78 miles of mountain road with heavy grades and in extraordinary bad condition, was wholly too small and nothing could be done but scratch over the surface of the roadbed in an endeavor to allow teams to pass. A considerable part of this money was applied to three bridges which were entirely unsafe for travel—the Eagle Creek bridge, Long bridge, and the Stanislaus bridge. The remainder was spent in filling over the 24 miles of rocky bed, cleaning out and diverting ditches, some very necessary culvert work, cutting out fallen timber, grading out the one mile of lava roadbed at Bald Mountain, and general patch-work.

Three heavy thunder-storms during the past year completely washed out the road in two places, and thus necessitated the expenditure of about \$400 in repair. After this work was finished, I traversed, September 11-12, 1904, the whole length of road and found the same in fair condition, considering the small amount of money available for expenditure. The Eagle Creek bridge is now substantial; the Stanislaus bridge was repaired, but can not more than survive this winter; and Long bridge, which was left to decay, has a temporary roadbed constructed for 450 feet on the sidehill around it. The 24 miles of rocky roadbed is much smoother than at any time since the State took control and the drainage has been greatly improved.

The road from Bridgeport, Mono County, to the junction where the Sonora road leaves the Antelope Valley road is built almost entirely in soil with scarcely any rock, which can be easily handled or worked with plow and grader. In the seventeen miles of this section there are few steep pitches or grades but what may be greatly reduced by a change of road line. From Bridgeport westward for about $2\frac{1}{2}$ miles the road is over flat meadow land very low and wet, which will require a heavy crown to prevent washing from the high waters of spring. This division of the total road can be made very good without a very heavy expenditure, and should receive proper attention, for it is a part of the

main road to Carson Valley and is traveled as much as any road in that section of California. From Junction in a westerly direction, the road extends 13 miles to the western boundary of Mono County at the summit of the Sierra Nevada Mountains and is principally over rough and rocky ground. The 30 miles of this road in Mono County will require the construction of one hundred and fifteen culverts and thirteen bridges; eleven of the latter are small structures, averaging perhaps fourteen feet in span, and two, the East Walker River span and the West Walker River span, are 70 feet and 40 feet respectively. Therefore, the estimate of this constructive work and of the grading and rock work is as follows:

	<i>Estimate.</i>
115 culverts, at \$25	\$2,875 00
11 small bridges, average 14 feet	6,000 00
2 bridges (fair size)	5,500 00
Grading	800 00
Rock work, 5 miles	2,000 00
Total for 30 miles	\$17,175 00

From the summit of the Sierra Nevada Mountains westerly to Baker's station, and from the foot of Patterson grade to Niagara Creek, the roadbed is composed of granite bowlders. In addition to this, there are short stretches of bowlders aggregating one mile in length, and also about $1\frac{1}{2}$ miles of exposed lava roadbed at Bald Mountain. Thus, out of a total length of 48 miles that traverses Tuolumne County, there are perhaps 19 miles over rough and rocky country, while the remaining 29 miles are through a timbered country with good soil. The number of bridges and culverts necessary on this section of road is as given in the following estimate:

	<i>Estimate.</i>
143 culverts, at \$25	\$3,575 00
15 small bridges, average 14 feet	8,250 00
Stanislaus bridge, 75 feet in span (must be built)	3,800 00
Eagle creek bridge, 35 feet in span	1,700 00
Rock work, 19 miles	7,000 00
Grading and ditching	2,000 00
Total for 48 miles	\$26,325 00

In view of my examinations and trips of inspection of the Sonora-Mono road work, it is recommended that \$25,000 be appropriated for the construction of culverts, bridges, and grading, \$5,000 of which be made available immediately; and also that the maintenance appropriation be increased to \$5,000 per annum.

MONO LAKE BASIN ROAD.

This road, which when completed will connect Mono county with the eastern extremity of the Tioga road and thus give that part of

California east of the Sierra Nevada Mountains a direct outlet to the central part of the State, has now been constructed for 4 miles of its eastern part; and the remaining distance is under contract for completion August 20, 1905.

By the original survey in 1901, the total length of this connecting road was 9.25 miles, which was divided into two sections for contracting purposes. In 1902 the available money was not sufficient to construct over about one half, and accordingly a contract was made with Mr. James Touhey of Sacramento for the construction of 4 miles, 1,010 feet of the eastern end for \$14,000. During this year he worked over about $3\frac{1}{2}$ miles of the contracted length, but did not finish such mileage. On account of severe storms, Mr. Touhey was compelled to withdraw from Mono County and wait until the following spring. In 1903 he returned to complete the remaining work under his contract, but particularly worked the one mile untouched the preceding year. Upon notification the first part of September, 1903, by Mr. Touhey, of the completion of his contract, I visited and examined the work accomplished and found the same not in accordance with the specifications. After a careful calculation, I recommended the payment of \$2,500 for the work of 1903, and retained \$3,500 of the original contract price of \$14,000. In the spring of 1904 I requested Mr. Touhey to complete his work in accordance with agreement, but upon his failure to begin such work, I formally notified him that under the terms of the contract I would relieve him of further work and undertake to finish the 4 miles, 1,010 feet of road in strict compliance with the agreement. Accordingly, on August 7, 1904, I employed Mr. T. Silvester as foreman and directed him in the work to be done. At this date there was held by the State the retention money of \$3,500, and a cash bond of \$1,000 which was to be used if necessary. Mr. Silvester with a crew of men has, at this date, completed 3 miles of the contract work in a most satisfactory manner. Further work this year, however, has been suspended by reason of the snow encountered.

The Legislature of 1903 appropriated \$25,000 for the completion of this road (that is, the construction of the remaining 5 miles, 593 feet), but did not make the appropriation available until January 1, 1904. Through a desire and effort to come to some understanding with the owners of the Tioga road proper, regarding their non-resumption of the collection of toll, much time was lost without accomplishing anything. Therefore the work on the last 5 miles, 593 feet of the road was delayed until this fall, too late to begin operations at an altitude of 8,000 feet until the spring of 1905.

On August 20, 1904, advertisements for sealed bids for the completion of the Mono Lake Basin road were inserted in a Sacramento daily paper for one week, and three weekly insertions each in the Bodie Miner-Index

and the Bridgeport Chronicle-Union. On September 6, 1904, the final date set for bids, there was but one received. Mr. J. F. O'Brien of San Francisco agreed to construct the road for \$23,861, and accompanied his bid with a certified check in the sum of \$4,000 as a bond for the performance of the work. His proposal being in proper form and very close to the filed estimate in this office of \$24,345 for this work, a contract was entered into with him, which was filed October 5, 1904.

Separate from the contract of Mr. Touhey was the bridge at station 203+25, which was built during 1903 by day labor at a cost of \$280. The structure has dry rubble masonry abutments filled in behind with rock and earth and a superstructure of tamarack timber, the planking of which is six inches in thickness. It is 20 feet in width and is sufficiently strong and well built to meet all requirements.

Much the greater part of this road follows along the side of the mountains up Levining Cañon and is cut out of solid or broken rock or rocky ground. When in the spring of the year the steep mountain sides above it are thawing, large quantities of rocks and boulders roll down and in many cases will lodge on the roadbed. The slope cuts which are new and not yet fixed in position will, with the storms, gradually slide into the road, necessitating, for the first three years, considerable work in the removal of such débris. With this knowledge there should be some provision made for the maintenance of the road, and I therefore recommend that \$800 per annum be provided for such work.

TRINITY-HUMBOLDT ROAD SURVEY.

The Legislature of 1903 appropriated \$1,800 for a survey for a wagon-road from the town of North Fork, Trinity County, to some point in Humboldt County at or near China Flat. The statute contemplated a route along or partly along the Trinity River, or a route to be found for the most feasible location of a road in the general direction of such river. The money became available January 1, 1904, making it incumbent upon this Department to conduct the survey during this year. Therefore on August 23, 1904, a surveying party was organized and proceeded to a point on the main Trinity River near the Trinity-Humboldt county line, where camp was pitched August 27. For four days thereafter Mr. G. W. Conners, the engineer in charge of the work, and myself reconnoitered the country for the first 8 miles up the river, and thereupon determined the location along the main stream and on the north side or sunny slope of the mountains. Other engineering features being reasonably without difficulty, a far superior roadbed can be obtained on ground where the sunshine strikes perpendicularly or nearly so to the surface. Especially in a country like northern California, where the timber and brush growth is much denser and heavier on the hillside receiving the least sunshine or the very slanting rays

of the sun, is this fact exemplified. For the foregoing reason our investigation covered the north river side so far as practicable for a road. Another point we carefully followed was a proper location for grade and alignment. My endeavors were to eliminate all ups and downs in the road and thus relieve California State roads of some of the disagreeable and expensive features of most of her county roads.

No doubt the location of a wagon road through this section of the State should follow just as a railroad would do, the natural courses of the streams and not be climbing hills when no necessity for such work exists. The banks of the Trinity River for about 25 miles on the Humboldt end of the proposed line of road are steep and precipitous for an elevation of approximately 100 feet above the river bed. Beyond this, for about 20 miles to the town of North Fork, the river bank is more gradual of descent, and excluding numerous short and narrow points of solid rock, is excellent road ground.

From the beginning of the survey on a Humboldt road near China Flat, the grade in no place will exceed three per cent, while there will be stretches of 4 and 5 miles with a one per cent grade. This grade occurs in the rougher section of the work, so that it is firmly believed that on the eastern end for 22 miles yet unsurveyed the grade can be made to not exceed one and a half per cent.

An item of serious moment in the cost of construction of this road is the bridge work. In the first 6 miles, the main Trinity River must be spanned with a 225-foot central truss and at least a 75-foot truss on each end; two 100-foot spans must be constructed at the Sehauber double sloughs; the Trinity River must, by the present survey, be crossed and recrossed to avoid a solid rock mountain just southeast of New River, where must be constructed a 150-foot span at Hawkins' Bar and another 225-foot span with one 50-foot and one 100-foot secondary span just below Don Juan Point. Almost any crossing selected on the river in the vicinity of the proposed road has excellent opportunities for solid rock foundations. The bedrock juts out from the banks usually from 10 to 25 feet above the summer flow of water, and will make substantial bases for the necessarily high structures required, for all the bridges crossing the main river will be at least 85 or 90 feet above the mean water level.

The 22 miles of survey now completed traverse more difficult ground than the remainder of the route shows by an examination made by myself September 1, 1904. With an earnest desire to obtain the best possible route at the least cost it seems that for the last 8 miles of the present survey a duplicate should be made on the opposite side of the river in order to calculate the difference in actual work.

A party of seven men, including cook, was employed under the direction of Mr. Conners, an engineer, up to October 10, 1904, when he

was compelled to leave the work. At the time of his departure there were completed 80,000 feet of road survey, giving all data required for contracting or building purposes. I then personally assumed charge of the crew and continued the work until October 25th, when 113,000 feet, or practically 22 miles, were finished. The appropriation, which was wholly insufficient for a survey of 45 miles of a rough mountain country, in a county difficult of access, was entirely expended on the work accomplished.

The data already obtained, giving 1,100 lineal feet in the five large bridges, and the 22 miles of road line with approximately 5 miles of difficult work and the remainder of easy construction; and a cursory examination of the yet unsurveyed part of about 22 miles which contain no large bridges and very little difficult ground, give enough information to make the following general estimate :

Estimate.

1,100 feet of large bridges-----	\$40,000 00
45 miles of road, at \$1,500 per mile-----	67,500 00

Trinity County, through which this road would run, with the exception of one half mile, is altogether without funds for an improvement of such magnitude, and yet its construction would be a splendid thing for the development of that section of California. I believe that if the road were built in three sections, thus reducing the heavy expenditure at one time, a very necessary and excellent mountain road could be made without being a burden to the State. By all means there should be appropriated \$2,400 for the survey of the remaining 22 miles and also a parallel survey to some of the present work to determine their relative costs.

EEL RIVER SURVEY.

Eel River, which is principally included within the bounds of Humboldt County, drains a large part of the southern and eastern sections of the county, besides receiving large quantities of drainage water from northern Mendocino County, a part of northern Lake County, and a small part of southern Trinity County. It flows in a general north-easterly direction, with a heavy grade until it reaches the valley some few miles above the mouth of the Van Duzen branch, where the fall reduces quite gradually until it empties into the ocean between Cape Mendocino and Humboldt Bay. The drainage area beyond the mouth of the Van Duzen River is well covered with a very heavy growth of timber and brush, which, at the present time, is a vast help in keeping in check extraordinarily heavy floods in the fertile Eel River Valley, extending about 18 miles in length and an average width of about 4 miles. As the timber is cut down for lumber, we can not but look for a much greater flow of water in a shorter space of time. The standing

trees and brush with their roots and soft top layer of soil and mold act very materially in the retardation of the run-off. As this condition passes then must we expect a diminished amount of percolation and retention by the soil of the rainfall, and then will be seen the necessity for a present protection of one of the most productive spots in all California. Even in the past years and during recent winters the capacity of this stream has been severely overtaxed to carry away the heavy rainfall of this section. If a severe winter occurs, practically the whole valley is inundated, and especially is this so if a heavy storm occurs at the time of the large spring tides, which back up the river for about seven or eight miles. When the waters coming down the upper stretches of the river encounter the slighter grade the immense amount of alluvium in suspension is partially deposited, and as the velocity continues to reduce the finer silts are precipitated, thus tending to raise the stream's bed at or near its mouth. By observation of the river at its low summer stage we note, as we descend, the heavier gravels give way to finer and finer material until we reach the alluvium deposits. The erosive power of water therefore tends to cut deeper and deeper the river-bed where the grade and consequent velocity are great. This deepening gradually reduces to zero as we travel toward the river's mouth. From this point, the velocity has not the power to clear the bed, but creates shoals, and the channel works back and forth, shifting the material to various locations. The sinuosities of a stream are created by a deflection, in the beginning, of some obstacle, and then as the force of the water is directed wholly or partly perpendicular to the bank, this necessarily, if of easily washed material, must gradually cause a turning of the river channel. The deflecting once started, continues until the water encounters another obstacle, again varying its course, and so on until we have in ground capable of being washed, a very crooked river, depending somewhat on its grade and therefore its velocity. Undoubtedly, most of us have seen the lodgment of a tree on a river gravel bar and noted the root end lying up stream, caused by its deeper draft and consequent catching on the bar and swinging its top down stream. We have also noted that above and around the roots a digging or hollowing out occurs, while a small shoal forms down stream from it. The barrier thus created by the roots checked the velocity, allowing an extra deposit to take place beyond it and as an impediment in the stream, the water is forced around it in all directions with a swirl that digs up the material, allowing it to be carried below by the velocity. The breakwater or wingdam, where contracting the width of a stream, always creates a faster flow capable of carrying in suspension material deposited under ordinary conditions and scouring out by increased erosive power between barriers or around the end if a wingdam or single jetty.

With Eel River the problem is one of difficulty. In a case of the kind, the engineering features are special for this one undertaking, therefore all details should be most carefully worked out before any start is begun. With this in view, let us gather if possible the peculiarities of the problem before we begin the application of general hydraulic plans and propositions.

The marshes near and in the vicinity of the mouth of the river were gradually, at some early date, built out between Table Bluff and the ridge of hills on the south. Then the ocean waves have through years been washing up the sands in a vain endeavor to close the mouth of the river. This is the general tendency of the waves to cut off irregular indentures along the coast and to form a smooth and more even line of seashore. The reasons for this are simple and shall, so far as our problem is concerned, be passed.

Thus the mouth of Eel River is ever changing in its battle with the ocean waves for an outlet. Sometimes the mouth is directly in line with the last stretch of river, and sometimes a sharp turn from such stretch is necessary for its waters to enter the ocean. In this latter case there is an immense friction to overcome on the turn which undoubtedly backs up the flow or tends to choke up the mouth. This part of the problem, although affecting a general scheme of improvement, is too vast to be handled for any accruing benefits to the valley.

At some time Eel River built up the principal part of Eel River Valley and now seeks to destroy it by its changing channels and cutting away of the banks. Travel over that valley and you will see various old river-beds left behind and partially filled by this same stream. Salt River itself at one time carried a large part of the waters going to the ocean from this valley. The natural question arises, why not let the river alone, for where it cuts into one bank the opposite side builds out and fills up? To a certain extent this is true; but wherever it is so doing the land made by this process is lower than the older deposits and has not a value comparable to them. The gravel beneath the thin covering of silt allows the moisture to percolate through as if a filter, thus creating a direct loss in the land wealth of this county and therefore to the State.

Practically there has been nothing done to prevent this loss of valuable land, not even some of the simple remedies which can not but be of some success. The banks are vertical or nearly so, composed of a light rich alluvium which melts away with astonishing rapidity. Whenever these banks become saturated either by the high water covering the land or by absorption, and the river begins to fall, thus relieving the hydrostatic pressure from the wall of silt, large masses tumble into the river and pass away down stream, not to be regained. Stand on the river's bank, and note when the largest amount of ground goes

out, and you will be convinced of the truth of this statement. To the people directly affected by the loss I would recommend a trial of the simple plan of cutting back the bank to a slope of say forty-five degrees or even a slighter slope and using a profusion of willows battened down with wires. In all cases this will not accomplish the end desired, but in some instances it will prove efficient, and should the willows obtain a good start will save, perhaps, the destruction of property. Of course it may require concerted action of the property-owners living on or owning the length of any particular stretch of high bank.

Eel River Valley has been cleared of brush and timber to adapt the land for dairying purposes; but it is my opinion more brush should be kept along the river's course, for some protection is afforded by even the roots. Particularly on the bars forming opposite the steep banks the willows and alders should not be destroyed, as they protect the land adjoining.

The necessary protection against the bank destruction along this river resolves itself down to the matter of riprapping the banks with rock sufficiently large to withstand the velocity, and of entangling the same with willow brush, which in time will form a solid brush and rock bank. By reason of the constantly changing course of the channel it is necessary that this work for any particular part be planned in the spring of the year for construction the same summer.

At some points which may be located on the maps of the present course of the stream, jetties built out would be highly beneficial for deflecting the river and causing a scouring out of a new channel; but as a general proposition for the purpose desired, riprapping the banks would prove the most efficient and least expensive.

In the interest of this protection work the river was completely surveyed from its mouth to the Van Duzen branch in 1903. Prior to the regular surveying crew being placed in the field, a levelman and assistants were employed from July 15th to August 5th for the purpose of locating bench marks and obtaining levels and tide gauge readings near the river's mouth. The field work proper began August 5th, being conducted under the supervision of Mr. H. S. Smith as engineer, and occupied three months for completion. During this time levels were run from the base of mean low tide, obtained after a month's readings on both banks of Eel River, to the Van Duzen River and the whole length of Salt River. Every 500 feet on either bank were established firm stakes with elevations, with permanent benches at all opportunities on trees. Meanders were run on both sides of Eel and Salt rivers; all topographical features were noted, old river courses were determined, as well as the quantity of brush available and property divisional lines. The whole length of river was either cross-sectioned or sounded every 500 feet in length and all general conditions

were determined. Both sides of the river were staked on the survey, so that at least a complete line of transit points may be had, even though large tracts of land where the stakes set may be washed away.

The maps and data now in possession of this office are such as to be valuable in the study of the river conditions, and as time goes by will be a great source of help in the determination of any work thereon. The cost of the work to date is approximately \$3,800.

A project of the magnitude contemplated in the statute of 1903 can not be fully accomplished without the expenditure of a large sum of money. If we resorted to the riprapping of the exposed high banks at the date of the survey in 1903, 14 miles of the work would be necessary, while in addition some river jetties would be indispensable. Assuming all rights of way to be free, the probable cost of the foregoing will approximate the given general estimate, as follows:

Estimate of Riprap Work.

Bank sloped to 30°—earth removal.....	\$59,000 00
Brush used in conjunction with rock.....	27,000 00
Rock dumped at work.....	517,500 00
Labor.....	85,000 00
Incidentals.....	25,000 00
Total.....	\$713,500 00
Jetties, per 1,000 feet of length.....	28,000 00

The people owning property in the Eel River Valley adjoining the river have at times endeavored to stop the ravages of the floods in a small way, but so far their efforts have proven futile. Therefore, I earnestly believe that assistance granted them by actual work, so that they may watch its practicability and ability to prevent further damage at the point of application, would result most beneficially. It would certainly stimulate the land-owners to a greater effort in their own behalf.

An appropriation of \$35,000, with an equal sum from Humboldt County or the people of the Eel River Valley, would, I think, be ample to construct a section of permanent work sufficient in magnitude to be of substantial value and present an excellent example to those directly interested in the protection of this land wealth.

YOSEMITE VALLEY.

The engineering work of the Yosemite Valley has partially come under this Department through requests from the Commissioners having in charge the conduct of its affairs. The results of my visits there are better given in my reports to the Commission, and I therefore give their text in full:

SACRAMENTO, CAL., September 21, 1903.

To the Honorable Yosemite Valley Commissioners, San Francisco, Cal.:

GENTLEMEN: Pursuant to a request made by your Commission to investigate and examine the condition of the Yosemite Valley roads and bridges, and offer some plan of improvement of the former, I desire to submit the following report and suggestions for your consideration:

During the latter part of August, 1903, I traveled and examined all the roads of the valley and the trails on which are located bridges, and closely observed the character of both soil and rock formation, as also did I pay attention to the Merced River's position to furnish water for sprinkling. All the bridges except the new one on the Yosemite Point trail were visited and thoroughly inspected.

The kind and condition of the roads and bridges are in deep contrast to the magnificence of the valley, and certainly show that the prime item in the work of the valley is the improvement of the roads.

There are between 22 and 23 miles of road within the bounds of the valley, and of these there are perhaps 14 miles in the floor of the valley. These 14 miles are almost wholly of a decomposed granite sand, varying considerably in coarseness. In a few places may be found an alluvium deposit which modifies the character of the roadbed to an approach to the ordinary dust road. In general the floor of the valley is composed of this decomposed granite sand, with the result that the roads are heavy and very disagreeable to travel.

Three plans are here given looking to the improvement, as also are the difficulties attending each:

First, might be suggested that sprinkling with water taken at intervals along the Merced River be resorted to; but this becomes so very expensive as to be at present prohibitive. The granite sand retains so much of the heat from the sun and consequently evaporation is so rapid that it is difficult to keep the road sufficiently dampened for travel, and this, too, with constant work.

Secondly, the plan to macadamize and thus build good and substantial roads is one that under ordinary circumstances meets with approval; but in the valley there is no available rock for such purposes, and this scheme becomes impracticable. All the rock formation in and near the valley is granite, which is unsuitable for macadam work.

The third and at present last plan is the application of oil to form a road crust and thereby give the desired effect of reducing the pull and the dust. It is upon this plan I shall deal most fully, for it now appears to me to be the most feasible, although some difficulties will be encountered. I believe with care in the application of oil a considerably improved condition of road will result in the valley; but before suggesting too strongly this plan I desire to call your attention to the following facts:

The roads should be made to conform to true grades, with good alignment, and all ruts should be properly filled and all rocks should be taken out. Then there should be enough crown given to prevent damage by water, and the roadbed prepared to receive the oil. Again the question of width of road is one of importance, and as the conditions of travel determine this, a 16-foot roadbed, it seems to me, is none too wide for the needs of the valley.

After road bed preparation has been made to receive oil, I would apply per mile about 225 barrels of crude oil in its cold state to a width of 10 or 12 feet. Certainly the cold oil will be readily taken up by the porous sand roadbed. After thorough incorporation of the sand and oil and rolling the road if necessity requires, a first year's oiling would be completed. During the second year in my judgment 100 barrels of oil per mile should again be applied to make a good road crust and give satisfactory results.

However, with results on oiled roads we now have to base an opinion on, regarding the different kinds of roadbeds, I earnestly believe, before any extensive work of this nature be done, that a wise plan would be to experiment for say a half mile or a mile with oil on this granite sand, and determine what quality of road such without a mixture of silt or alluvium will give.

BRIDGES.

An examination of all the bridges except the Yosemite Point trail bridge was made, and all except two were found in fair condition. The abutments, built of dry masonry,

are very substantial, and the timbers in all structures showing any decay whatever were bored and all the rotten parts detected.

In all I examined eleven road bridges and four trail bridges, and found only two in need of repairs or replacement. The one at Lick House, of 63-foot span, needs replacing by a new bridge, and the one near El Capitan, of 90-foot span, was dangerous for travel, through failure of parts of a bad design. I gave the Guardian, Mr. Stevens, details of work that should be done on this structure to hold it solidly in place, and suggested that the work be done immediately.

In replacing the bridges and culverts of this State property I think it not amiss to recommend the use of stone in both such structures. In time it would prove economical and vastly more in harmony with the immense granite valley.

I append hereto an estimate of the cost of oiling the valley roads, and also a list of the bridges, with size and condition.

Knowing that at times there is need of engineering assistance on the work of the valley, I hold myself in readiness at your request to aid your Commission so far as within my power.

Very respectfully,

N. ELLERY,
Highway Commissioner.

Estimate of Oiling Valley Roads (One Application), 10- to 12-foot Roadbed.

Oil, 225 bbls. per mile, first application, delivered at Raymond, at 70 cents.....	\$157 50
225 bbls. freight to Valley from Raymond, at 1 cent.....	742 50
Toll for 9 trips of 10 animals each, at \$1 per head.....	90 00
Distributing the oil in valley, and work incidental thereto.....	150 00
	<hr/>
	\$1,140 00
Five per cent extra.....	57 00
	<hr/>
	\$1,197 00
Plant to be used on any number of miles:	
Four tanks delivered at Raymond.....	\$450 00
Oiling attachment and extras.....	200 00
	<hr/>
	\$650 00

Yosemite Valley Bridges. (Condition August, 1903.)

	Kind.	Span.	Condition.
		<i>feet.</i>	
1. Main bridge near Sentinel Hotel.....	Iron.....	101	Fair; very light structure.
2. El Capitan bridge.....	Wooden truss.....	90	Must be repaired.
3. Yosemite Creek bridge.....	Wooden truss.....	45	Good.
4. Bridge at Power-House.....	Wooden truss.....	63	Good.
5. Lick House bridge.....	Wooden truss.....	63	Bad; should be rebuilt.
6. Bridge near Camp Curry.....	Wooden truss.....	80	Good.
7. Tenaya Creek bridge.....	Wooden truss.....	58	Good.
8. Pohono bridge.....	Wooden truss.....	82	Fair.
9. West branch of Bridal Veil Falls bridge.....	Wooden stringer.....	25	Fair.
10. East branch of Bridal Veil Falls bridge.....	Wooden stringer.....	32	Good.
11. Middle branch of Bridal Veil Falls bridge.....	Wooden stringer.....	52	Fair.
TRAIL BRIDGES.			
1. Bridge near Vernal Falls.....	Wooden truss.....	57	Good; 50-ft. approach.
2. Bridge below Nevada Falls.....	Wooden stringer.....	47	Fair; railing loose.
3. Bridge above Nevada Falls.....	Wooden truss.....	50	Good.
4. Illilouette bridge.....	Wooden stringer.....	48	Fair; sill on west end rotten.

The three stringer bridges over the forks of the Bridal Veil Falls stream could be built of stone of the following spans; 10 feet, 20 feet, and 20 feet respectively.

Lick House bridge should certainly be replaced before next year's travel.
Cost for wooden-truss bridge is very closely \$500.

Respectfully,

N. ELLERY,
State Highway Commissioner.

SACRAMENTO, CAL., June 18, 1904.

To the Honorable Yosemite Valley Commission, San Francisco, Cal.:

GENTLEMEN: The request of your Commission to experiment with oil in the betterment of road conditions in the Yosemite Valley was carried out during my stay there from May 24 to June 4, 1904. The experience and conditions attending such work are here given in detail for your consideration, as are also other road and engineering items that came to my attention.

Prior to my arrival, Mr. Stevens, the Guardian, prepared three stretches of road for the application of oil. Two of these were on the main road between the Sentinel Hotel and the El Capitan bridge, on the south side of the Merced River. They were given a crown of 8 inches for a width of 14 feet, of a material composed mostly of granite sand. The third piece of road was across the meadow land between the Sentinel Hotel and the Yosemite Camp. It was crowned 6 inches in 16 feet of width, and was composed of silt, gravel, and sand.

On May 26, 1904, there were received in the valley four tanks of oil of 25 barrels capacity each, which on May 27th was applied as follows: 50 barrels were distributed on the Sentinel Hotel-Yosemite Camp road for a distance of 840 feet and a width of 12 feet, thus making approximately an average of 300 barrels to the mile; and 50 barrels were distributed on a piece of the Sentinel Hotel-El Capitan road for a distance of 2,050 feet and a width of 8 feet, thus making approximately 190 barrels per mile.

The apparatus to conduct the work was crude. In the use of the mountain wagons and teams by which the oil was transported, great difficulty was found in keeping the prepared road surface intact. The wagons had very narrow tires, and when containing the oil weighed about 15,000 pounds. In using them to distribute the oil, they cut the road surface into a veritable plowed ground, thus requiring considerable more oil than otherwise, with far less beneficial results. Then no oil could be held in reserve for such places as were not sufficiently covered to give a good even surface. This again added a difficulty.

On the Sentinel Hotel-Yosemite Camp road, the oil after application was sanded and rolled as thoroughly as our appliances would permit. It certainly received as fair a test as the circumstances would allow, and I believe that with the exception of some weak spots in the oiled surface, it will give a good idea of the ability to make a road surface of oil in the valley. In regard to the other oiled piece, it was my intention to demonstrate the fact that the oil in insufficient quantity and without further care will practically last but a year or two and then become worn out and gone, when to again prevent dust another application is necessary. The expense of such renewals without any permanent result is surely most unsatisfactory and far too expensive to warrant such work. What is desired is a permanent road surface, and to obtain this on the character of soil at hand there must be used from 300 to 350 barrels of oil per mile on a 12-foot strip of road. Even this is not the best for the travel to which the valley roads are subjected.

To my mind the improvement of these roads should be substantially permanent for heavy travel, and in making experiments for this purpose nothing but the best and most economical plan should be sought. Therefore I earnestly believe that a far more satisfactory and lasting road can be built there by the application of the macadam principle for a foundation with an oiled surface. With this view I suggest to your body the plan of constructing a piece of road of the river gravel obtained at points along the Merced River. This gravel without surface protection would be useless on

your roads and would entail unnecessary expense, while if protected with an oil covering would give very good results. It is certainly the best for the valley's travel to have good rock foundations for your road work; and it can be stated without reserve that the above-mentioned river gravel properly handled and applied and then oiled will effect a far better result and will prove much more economical of maintenance than the direct application of oil to the present condition of roadbed and surface.

There are at least 15 miles of roads on the floor of the valley to be improved. To do this work in a thorough manner with oil would require about 5,500 barrels and the purchase of proper appliances for such work. But before any action is taken I desire to recommend a trial of the graveled and oiled road that you may discern the relative efficiency of the two methods. This suggestion is made after careful observation of the oiling already done.

While in the valley I looked over the iron bridge which spans the Merced River at the Sentinel Hotel, and had it tightened. This structure is of very light weight and needs yearly inspection. In the matter of the new El Capitan bridge, I made measurements of the old structure so that the new design which is now being made will avoid any of the weak points that caused failure in the old bridge.

I visited the new reservoir once in company with Guardian Stevens and again with Messrs. Short and Hender, and found the location and work well suited for its purpose. When finished this work will be substantial and far superior to any plan of building with rock and cement.

Another item that came to my attention through Mr. C. A. Givens was the lack of any plat or survey of your sewers or water mains in and about the town of Yosemité. To have an intelligent idea of those systems, it is necessary that you have a contour map showing the lines of pipes, connections, relative elevation, branches, and other relative data, by which you may easily outline any new or contemplated work or connections with the present work. I verbally offered my services in this matter to Mr. Givens, and herewith further offer to do such work upon my next visit to the valley if so desired by your Commission.

Upon the request of the Commission, on June 5th I visited and closely examined the big tree known as the Grizzly Giant, in the Mariposa big trees. It was found to lean 18½ feet from a vertical line and to have some partially decayed surface roots on the side farthermost from the lean. To ascertain whether or not it has of late increased its deflection from the vertical line is difficult and uncertain, but I established transit points by which any further movement may be accurately detected. Mr. Leach, the guardian of the trees, accompanied and assisted me in this work, and I gave him points by which he can determine any movement of the tree. The destruction of this giant sequoia can be stayed by attaching two cables sufficiently divergent to each other to form a substantial triangle; the cables to be fastened to pine trees near by, but unconcealed from the view of visitors. The resort to this plan is suggested, providing any additional deflection is determined.

Very respectfully,

N. ELLERY,
Highway Commissioner.

Additional to the foregoing, the plans in detail were gotten out by this department for a new wooden bridge over the Merced River at El Capitan. The span is 90 feet, which makes it the second largest bridge in the valley. The lower chords were single sticks hewn from the yellow pine near the site, and thereby avoided any joint near the center, which was the cause of failure in the old structure.

All the bridges of this State property with the exception of the iron structure near the Sentinel Hotel are made of wood and are, in consequence, very short lived. Twelve years is about the average length of their usefulness in that climate, while bridges built massively and

rough of the broken granite found at most points along the valley would practically be indestructible. The first cost would be a little greater, but the reconstruction and maintenance would be reduced to a minimum.

TRAVELING AND CONTINGENT APPROPRIATION.

In 1901 the traveling and contingent appropriation of this Department was reduced to \$250 per annum, and has so continued at that figure up to the present time. This is wholly inadequate for the purposes intended. The necessary travel in connection with the State roads and surveys costs considerably more than such appropriation, and outside traveling for road purposes must be done away with if the contingent fund is relied on at its present amount. A trip of inspection of the oiled roads of California for gathering data on the subject has so depleted the above appropriation that there will be a deficiency of \$100. I therefore ask for an appropriation of \$100 for contingent expenditures for the remainder of the fifty-sixth fiscal year, and that the traveling and contingent appropriation be increased to \$750 per annum.

MISCELLANEOUS WORK OF THE DEPARTMENT.

At the request of the Boards of Supervisors of Marin and Sonoma counties, I accompanied Mr. Richardson and Mr. Smyth, county surveyors respectively of the above counties, and advised with them on the location of a bridge site on a proposed line of road, over Petaluma Creek near Black Point.

During June, 1904, I visited Sonoma County and recommended to the Board of Supervisors the construction of a rubble-stone bridge on the Petaluma-Santa Rosa road at the point of crossing Petaluma Creek. A complete design in detail was made by this Department, of the following dimensions: Span, 24 feet; length over all, 34 feet; width of roadway, 18 feet in the clear; and rise, $5\frac{1}{2}$ feet. After an estimate of the cost of construction by this office the Board of Supervisors advertised for bids, which were received as follows:

Estimate of Rubble Stone Bridge.

115 $\frac{1}{2}$ cubic feet of concrete	\$23 10
5,143 cubic feet of rubble masonry	1,333 25
66 cubic yards of earth fill	19 80
140 cubic yards of earth cut	35 00
Total cost	\$1,411 15
Bids: \$1,145 (award), \$1,608, and \$1,789.	

The bridge over Sonoma Creek on the State property at Eldridge, Sonoma County, was carried away by the high waters of the winter of 1903-04, and at the wish of the Board of Managers of said property and F. W. Hatch, M.D., General Superintendent of State Hospitals,

I designed a steel structure with large concrete piers and wooden approach for the crossing. Every item in the work was made extra heavy and strong so that a good substantial bridge would be built. Pursuant to advertisement by the Board of Managers, bids were received, ranging from \$3,374 by Mr. James McMahon of San Francisco to \$4,457 by the Dundon Bridge Company of San Francisco. Mr. McMahon received the contract, and I was placed in charge of the work. During the construction work about eleven visits of inspection were made, and upon its completion my recommendation to the Board of Managers was for the acceptance of the work, provided \$125, which is ample, be deducted from the contract price for not strictly complying with the specifications in the matter of the concrete for the piers. However, the bridge as it now stands is an extra strong and substantial structure, with a large capacity for the work to which it will be subjected.

From 1902 to 1904 I have attended road meetings and participated in their work at the places and dates indicated: Martinez, May 30, 1903, State convention of Boards of Supervisors; Sonoma, December 15, 1903, road meeting; Elk Grove, March 23, 1904, Farmers' Institute meeting; Santa Barbara, April 19-20, 1904, El Camino Real Association meeting; Glen Ellen, May 30, 1904, good-roads meeting.

With the limited means at hand I have also visited and examined the methods of construction and results of a large number of oiled roads in the southern and central parts of California.

REPORT LAKE TAHOE WAGON ROAD COMMISSIONER.

ARTHUR S. LYON, COMMISSIONER.

SMITH FLAT, CAL., October 31, 1904.

*To His Excellency, GEORGE C. PARDEE,
Governor of the State of California:*

SIR: I beg leave to inform you that after assuming my duties on the 6th of January, 1904, as soon as was possible I traversed the Lake Tahoe Wagon Road as far as the snow allowed.

I found said road in fairly good condition with the exception of culverts which had previously been constructed of wood, and which were nearly all in a condition where they should be replaced either with stone or terra-cotta pipe culverts.

Starting early in the spring, I graded and rounded up about a mile and a third of roadbed through soil filled with bowlders, lava, and bed-rock formation. I used a bedrock plow, with a road-scraper to move most of the dirt, a considerable amount of powder being required to loosen the ground in places. I also handled three small slides which threatened to impede travel; all at a cost of about \$500.

I have also constructed seven stone culverts, at an average cost of about \$55 each. Also twenty-five terra-cotta pipe culverts, ranging from 6 to 18 inches in diameter, at a cost for labor of about \$25, and cost of pipe and hauling of about \$10 each.

As there are a good many of our larger waterways on this road that should have immediate attention, I would recommend that the next Legislature be asked to give \$10,000 to be expended only on bridges and culverts. Also, to appropriate \$5,000 to finish surveying this road, which has been done as far as the twenty-five milestone, and to deliver and place in position the remainder of the stones up to the State line. These stones are now stored at Riverton on the side of the road, and considerable comment is made as to why they are not placed in position, but the reason is that no official survey has been made further than said twenty-five milestone since the State acquired this road. Also, that the maintenance fund of \$4,000 per year is not any more than adequate to maintain the roadbed of this 60 miles of mountain road in good, passable shape. I therefore respectfully ask that the next Legislature give us a little more aid on this road, and by that means we will

be able to rebuild some of the walls on the lower side of the roadbed in places where they have slipped away, making the roadbed narrow, also causing comment about the road being allowed to run down.

I have spent in all since last January about \$3,200, all of which has been used in ditching and repair work, except as above mentioned, leaving about \$1,800 to spend in repairs to the 1st of July, 1905.

Respectfully submitted.

ARTHUR S. LYON,
Lake Tahoe Wagon Road Commissioner.

FINANCIAL STATEMENT.

(November 30, 1904.)

Trinity-Humboldt Road Survey.

1903—Appropriation	\$1,800 00
1904—Expenditures	1,677 12
Balance	\$122 88

Eel River Survey.

1903—Appropriation	\$5,000 00
1904—Expenditures to November 30	3,781 90
Balance	\$1,218 10

Mono Lake Basin Road.

1899—Appropriation	\$25,000 00
1904—Expenditures to November 30	23,903 68
Balance	\$1,096 32

1903—Appropriation	\$25,000 00
1904—Expenditures to November 30	366 60
Balance	\$24,633 40

Sonora and Mono Road Maintenance.

1903—Appropriation, fifty-fifth and fifty-sixth fiscal years	\$4,000 00
1904—Expenditures to November 30	3,804 09
Balance	\$195 91

Traveling and Contingent.

1903—Appropriation, fifty-fifth and fifty-sixth fiscal years	\$500 00
1904—Expenditures to November 30	323 19
Expenditures not yet paid	108 40
	431 59
	\$68 41

Lake Tahoe Wagon Road Maintenance.

1903—Appropriation, fifty-fifth and fifty-sixth fiscal years	\$8,000 00
1904—Expenditures	6,320 30
Balance	\$1,679 70

Amounts of Taxes Levied in the Several Counties for County Road Purposes and Expended by the Boards of Supervisors.

COUNTIES.	1903.	1904.	Totals.
Alameda	\$110,077 11	\$90,296 51	\$200,373 62
Alpine	1,688 25	1,843 32	3,531 57
Amador	20,635 30	17,632 39	38,267 69
Butte	53,994 98	56,116 27	110,111 25
Calaveras	20,603 83	21,774 58	42,378 41
Colusa	37,922 94	38,694 11	76,617 05
Contra Costa	35,041 95	50,332 16	85,374 11
Del Norte	7,659 56	9,762 93	17,422 49
El Dorado	12,110 26	13,625 51	25,735 77
Fresno	68,789 20	72,681 48	141,470 68
Glenn	28,101 07	25,789 31	53,890 38
Humboldt	73,313 32	69,028 10	142,341 42
Inyo	3,919 66	5,488 47	9,408 13
Kern	47,806 88	44,835 36	92,642 24
Kings	18,687 54	18,681 60	37,369 14
Lake	15,627 04	14,925 68	30,552 72
Lassen	14,250 60	15,692 99	29,943 59
Los Angeles	221,392 96	223,956 68	445,349 64
Madera	22,397 02	20,023 01	42,420 03
Marin	30,655 40	28,549 16	59,204 56
Mariposa	9,080 58	9,664 02	18,744 60
Mendocino	44,507 61	37,644 25	82,151 86
Merced	41,422 76	42,321 13	83,743 89
Modoc	13,650 51	13,414 95	27,065 46
Mono	2,871 95	2,240 06	5,112 01
Monterey	67,197 90	55,821 64	123,019 54
Napa	23,547 32	28,521 95	52,069 27
Nevada	17,380 92	17,577 74	34,958 66
Orange	36,202 50	33,449 30	69,651 80
Placer	20,892 64	21,451 24	42,343 88
Plumas	12,984 66	21,325 28	34,309 94
Riverside	23,817 78	22,087 62	45,905 40
Sacramento	66,310 84	51,536 12	117,846 96
San Benito	17,521 88	17,699 83	35,221 71
San Bernardino	38,008 92	34,649 06	72,657 98
San Diego	39,295 77	33,906 89	73,202 66
San Francisco*			
San Joaquin	77,216 63	79,777 81	156,994 44
San Luis Obispo	41,648 45	42,337 08	83,985 53
San Mateo	63,802 94	69,159 01	132,961 95
Santa Barbara	45,995 84	42,887 18	88,883 02
Santa Clara	142,347 79	127,158 74	269,506 53
Santa Cruz	30,653 78	31,326 73	61,980 51
Shasta	26,621 54	27,748 05	54,369 59
Sierra	6,254 75	6,331 09	12,585 84
Siskiyou	25,074 83	38,019 93	63,094 76
Solano	56,460 48	52,150 71	108,611 19
Sonoma	73,695 39	74,356 70	148,052 09
Stanislaus	38,608 53	41,476 30	80,084 83
Sutter	20,404 85	18,231 90	38,626 75
Tehama	27,412 89	28,305 36	55,718 25
Trinity	6,605 45	7,979 37	14,584 82
Tulare	44,347 15	46,132 63	90,479 78
Tulolumne	23,714 68	36,904 22	60,618 90
Ventura	35,782 62	27,830 55	63,613 17
Yolo	48,730 18	51,245 68	99,975 86
Yuba	10,033 52	13,749 68	23,783 20
Totals	\$2,164,781 70	\$2,146,139 42	\$4,310,921 12

*San Francisco: Incorporated as a city and county. No expenditures on roads.

